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Status of SSN-21 Ship Construction Program

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The Honorable Edward M. Kennedy
Chairman, Subcommittee on Projection
Forces and Regional Defense
Committee on Armed Services
United States Senate

The Honorable John R. Kasich
House of Representatives

This report is the unclassified version of the classified report we provided you in November 1989 on the results of our review of the Navy's Seawolf Nuclear Attack Submarine (SSN-21) construction program. Our objectives were to address the program's status, the SSN-21's performance capabilities, and the Navy's ability to maintain the nuclear attack submarine (SSN) force structure.

Results in Brief

The Navy is using two shipyards to design the SSN-21 and is proceeding with its ship construction plans. During the research and development phase, the program experienced some cost increases and a revised delivery schedule. Indications are that further cost increases and schedule adjustments are possible, and it is unclear whether overall performance goals will be met since the lead submarine will not be available for testing until 1995. The SSN-21's shipbuilding plan is designed to achieve the Navy's 100 SSN force goal. However, fiscal constraints and ship cost may prevent the Navy from achieving its SSN force goals.

Background

The 100 nuclear attack submarine force is a keystone of the Navy's maritime strategy and the new SSN-21 is to be one of the principal components of that force. The Navy sees no alternative to the SSN-21 in providing the quantum improvements needed in submarine warfighting capability. According to the Navy, the SSN-21 is needed because of Soviet deployments of more capable and quieter SSNs and because space and weight limitations prevent further performance improvements to the Los Angeles class nuclear attack submarine (SSN-688). Designed to be quieter, deeper diving, and tactically faster, the SSN-21 also will carry more weapons than the SSN-688s being built today. In addition, a new combat system (AN/BSY-2) is expected to provide the SSN-21 with a greater capability to detect, classify, localize, and launch weapons against enemy targets. (See app. I.)

The SSN-21 construction program is a major Navy initiative. Between fiscal years 1989 and 2000, the Navy plans to award contracts for 29 SSN-21s, including combat systems, at an estimated cost of $36 billion. The SSN-21 program is completing its detail design phase, and in January 1989 the Navy awarded the Electric Boat Division of General Dynamics Corporation a construction contract for the first ship. Some research and development and detail design effort will continue concurrently with construction of the lead submarine. Construction of the first ship began in October 1989 and delivery is scheduled for May 1995. In terms of 1985 base year dollars, the first SSN-21 is estimated to cost $1.6 billion and the Navy expects the unit cost of the next three SSN-21s will decline to the point that the fifth and the 24 following SSN-21s will not exceed $1.0 billion each.

Program Status

The SSN-21 shipbuilding program has experienced cost increases over estimates and a 6-month schedule adjustment. Newport News Shipbuilding—the lead shipyard for submarine design—has reported increased costs under its cost-plus-fixed-fee design contract that has an authorized cost of $343 million. Not yet included in the authorized cost is $5 million for submarine redesign caused by changes in the configuration of the combat system. Electric Boat, which is designing the engine room and its equipment also under a cost-plus-fixed-fee contract with an authorized cost of $212 million, shows a cost increase in its cost report. The Navy contended that the cost increase figure was invalid because the contractor's budgeted costs, against which actual costs were compared, were incomplete. The amount of the individual cost increases is considered to be proprietary by the contractors. According to the Navy, it agreed to a 6-month schedule adjustment for constructing the first SSN-21 to secure a lower price.

The AN/BSY-2 combat system development program could further exacerbate the SSN-21 program's cost and schedule problems. Managed separately from the SSN-21 program, the AN/BSY-2 is critical to the submarine achieving its full mission and performance capabilities. The combat system's development schedule is set by the ship's construction schedule, and the Navy has no alternate system planned should the AN/BSY-2 development be delayed. In October 1988 Newport News Shipbuilding indicated to the Navy that, on the basis of its assessment, it believed the AN/BSY-2 development program was 12 to 16 months behind that needed for the lead submarine delivery schedule. The Navy has since extended delivery of the lead submarine 6 months, to May 1995.

As of March 1989, design of the combat system was about 3 months behind schedule and two important Navy design reviews had been delayed about 5 months. In addition, the Department of Defense (DOD) has identified problems in developing two combat system components. Further combat system changes could have a major impact on completed SSN-21 design, with an adverse effect on program cost and schedule.

Until the first SSN-21 is built and fully tested, the Navy will not know the exact extent to which the SSN-21 will achieve its performance goals. Except for the two components, component and system development test results appear satisfactory.

A more detailed discussion of the SSN-21 program and the AN/BSY-2 combat system is provided in appendix II.

Operational Testing

Section 2366 of title 10 of the United States Code provided that major defense acquisition programs may not proceed beyond low rate production until operational testing and evaluation is completed. The acquisition schedule for the SSN-21 program provides that contracts for 14 submarines are to be awarded before the first ship is available for operational testing. The Navy plans to begin construction of the second and third SSN-21s more than 4 years before the lead ship is ready for operational testing.

In an opinion dated February 27, 1989, we concluded that the SSN-21 program could not proceed beyond low-rate initial production on the basis of "early operational assessments" that did not constitute operational testing.[1]

The Navy believed that waiting for operational testing of the first SSN-21 before contracting for more submarines would delay the program 5 or 6 years and entail a large cost increase. The Navy, therefore, had no plans to change its acquisition schedule. However, in its comments on a draft of our November 1989 report, DOD indicated that actions were underway to seek legislative relief from the current requirement. Subsequent to our November report, the Congress resolved this issue in the Navy's favor.

[1]GAO letter to the Chairman, Legislation and National Security Subcommittee, House Committee on Government Operations,B-222986, Feb. 27, 1989

SSN-21 Affordability

The Navy believes the SSN-21 will allow it to maintain far-term submarine superiority into the next century. Yet, fiscally constrained budgets may not allow the Navy to buy all of the SSN-21s it needs to achieve and maintain its 100 SSN force. To achieve its SSN force goal and execute its SSN-21 shipbuilding program, the Navy, according to our analysis, with sustained annual shipbuilding and conversion budget growth of 3 percent above inflation, will need to increase the SSN's share of the shipbuilding and conversion budget from 19 to 26 percent. Further, during a period of zero or negative real growth budgets, the Navy's planned SSN program could consume up to 36 percent of its total shipbuilding and conversion budget, which may affect Navy total force structure decisions. (See app. III.)

The Navy could achieve its SSN force level goals by building a mix of SSNs. This might entail acquiring fewer SSN-21s and more of the less costly SSN-688s. However, the Navy does not consider this a viable alternative to the SSN-21 program. According to Navy officials, if SSN-21 affordability becomes an issue they would rather reduce the SSN force level.

Conclusions

Without aggressive funding, the Navy will probably have difficulty achieving its SSN force goal and executing its SSN-21 program. SSN-21 affordability issues will likely require the Navy to make total force, as well as SSN force, trade-off decisions. The Navy also may experience difficulties in achieving its current SSN-21 construction plan because the AN/BSY-2's development, which is critical to the SSN-21 construction program, may not be completed when the first submarine is delivered. The SSN-21 will not be operationally tested until after construction of the second and third ships has started; therefore, the Navy will not precisely know whether the SSN-21 will provide the warfighting capabilities needed.

Recommendations

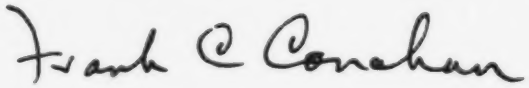
In our November 1989 report, we recommended that the Secretary of Defense direct the Secretary of the Navy to either (1) ensure that the SSN-21 and its combat system undergo operational testing and evaluation before proceeding past low-rate initial production, as required in the law, or (2) seek legislative relief that would change the law to either exempt shipbuilding in general or the SSN-21 program specifically.

Agency Comments and Our Evaluation

DOD generally agreed with our report and with the facts as presented. In some cases it disagreed as to how those facts were characterized and provided an update to the Navy's SSN force structure data. Where appropriate, we modified the report to reflect DOD's position.

DOD agreed with our recommendation that the Navy either seek legislative relief or comply with the law. It indicated that actions were underway to seek legislative relief from the current requirement. In November 1989, Public Law 101-189 was enacted, which allows shipbuilding programs to proceed prior to the completion of operational testing of the first ship.

This report was prepared under the direction of Martin M Ferber, Director, Navy Issues, who may be reached on (202) 275-6504 if you or your staff have any questions. Other major contributors are listed in appendix IV.



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Abbreviations

CAIG	Cost Analysis Improvement Group
DOD	Department of Defense
OSD	Office of the Secretary of Defense

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Role of the Navy's Nuclear Attack Submarine Force

"Submarine superiority" is a keystone of the Navy's maritime strategy. To fully execute that strategy, the Navy says it needs a battle force[1] that includes a minimum of 100 nuclear attack submarines (SSNs). The SSN force level was set by the Secretary of the Navy in 1982. Subsequently, in 1984 the Navy conducted a study[2] that identified a higher SSN force level requirement. Although larger force level requirements have been identified, fiscal constraints have kept the Navy's SSN force level goal at 100 SSNs.

The Maritime Strategy

The U.S. Navy's maritime strategy is a forward deploying strategy. The objectives of the strategy are to deter not only war but also less extreme acts of violence. If war breaks out, however, the objectives are to destroy enemy maritime forces, protect allied sea lines of communication, support the land campaign, and secure favorable leverage for ending the war.

U.S. Attack Submarine Force

The U.S. SSN force is substantially outnumbered by the Soviet submarine force; however, it has traditionally overcome this numerical disparity through a qualitative superiority. Although the Navy estimates that the U.S. SSN force will have a qualitative advantage over the Soviet submarine force through the 1990s, that advantage will continue to erode, especially as the Soviet Union deploys new submarines. Over the last 10 years, the Soviet Union has introduced five new SSN classes.

At the beginning of fiscal year 1989, the Navy had 97 SSNs in its active force—39 were Los Angeles class (SSN-688) and the others were older class submarines. While completing the SSN-688 construction program—23 more submarines—the Navy is moving forward with plans to construct the new Seawolf class (SSN-21). The Navy views the SSN-21 as ensuring technological advantages over Soviet submarines into the 21st century.

Developing SSN-21 Characteristics

Recognizing that the Soviets were closing the SSN qualitative gap, the Navy, 2 years after the first SSN-688 became operational, began studying various concepts for a new SSN, as well as possible improvements to the

[1] This force is commonly referred to as the "600-ship Navy" and represents a desired ship mix that includes 15 deployable aircraft carriers and 4 battleships as centerpieces of this force through fiscal year 2000.

[2] Submarine Employment Study, Feb. 1984.

SSN-688 design. The Navy concluded that the main determinants of effectiveness were noise level, combat system performance, and weapons' load and that a versatile, highly mobile, multimission submarine was the most cost-effective system to meet the objectives of national policy and its maritime strategy. The Navy, on the basis of its studies, established the basic SSN-21 design in 1982 and 1983.

The Navy believes that the SSN-21 will be three times better than the improved SSN-688. It will be the largest, quietest, and most heavily armed SSN the United States has ever built. Compared with the SSN-688, the SSN-21 is expected to (1) have a propulsion plant that will have more power per unit of weight, (2) carry more weapons, (3) have more launch tubes, (4) be less detectable, (5) have a faster tactical speed,[3] and (6) have an improved propeller (called a propulsor) and a new combat system. The Navy believes the SSN-21 will have quantum improvements over existing SSNs and will restore much of the qualitative advantage its SSNs have lost to the Soviets.

In addition, the SSN-21's size will permit the Navy to make improvements to enhance the submarine's performance. By comparison, Navy projections show that, because of its size, further SSN-688 class performance improvements are limited—in other words, before something new can be installed something has to come off. The Navy sees no alternative to the SSN-21 if it is to obtain the needed quantum improvements in submarine warfighting capability. To take full advantage of the SSN-21's enhanced performance capabilities, to address shortfalls in existing combat systems, and to counter the Soviets' gains in submarine quieting and acoustic sensors, the Navy also is developing a new submarine combat system (AN/BSY-2)[4] for the SSN-21.

Objectives, Scope, and Methodology

The Chairman, Subcommittee on Projection Forces and Regional Defense, Senate Committee on Armed Services, and Representative John R. Kasich requested us to examine various aspects of the SSN-21 program. Our objectives were to address (1) the program's status, including scope and cost of the SSN-21 research and development efforts, basic capability and performance questions about the SSN-21, and potential

[3]Tactical speed is the highest speed at which a submarine can operate and still detect potential enemy submarines and ships without being detected in return.

[4]The AN/BSY-2 combat system development program is discussed in our report entitled Navy Acquisition: Cost, Schedule, and Performance of New Submarine Combat Systems (GAO/NSIAD-90-72, Jan. 31, 1990).

impact the AN/BSY-2 combat system development program could have on the SSN-21 construction program, (2) the potential effects that the SSN-21's costs could have on the Navy's shipbuilding and conversion budget, and (3) the Navy's ability to maintain the 100 SSN force goal during periods of constrained budgets.

To accomplish these objectives, we reviewed Navy documents, studies, and publications and held discussions with responsible Navy and other DOD personnel. In addition, we analyzed the Navy's SSN-21 ship construction plans and relevant budget and force structure data and evaluated cost, schedule, and performance data for the SSN-21 and AN/BSY-2 development programs. Since the SSN-21 program had only entered the construction phase in January 1989, we could not determine whether overall performance goals would be met. In our analysis of current SSN force levels and current and future SSN construction programs, we estimated future SSN force levels. This part of our analysis provided (1) information on the numerical differences that might exist between the Navy's SSN force level goal and its SSN construction plans and (2) an extrapolation of expected SSN force levels in fiscal years 1990 through 2010. We did not question or validate the Navy's judgment on how the 100 SSN force goal was developed or whether this is the proper force level to execute the maritime strategy.

We conducted our review between December 1987 and May 1989 in accordance with generally accepted government auditing standards. Our work was performed primarily at the Departments of Defense and Navy, Washington, D.C.; Newport News Shipbuilding and Drydock Company, Newport News, Virginia; and Electric Boat Division, General Dynamics Corporation, Groton, Connecticut. We also visited the

- Naval Underwater Systems Center, Newport, Rhode Island;
- David Taylor Research Center, Carderock, Maryland;
- David Taylor Research Center, Acoustics Research Detachment, Bayview, Idaho;
- Navy Operational Test Force, Norfolk, Virginia;
- Bettis Atomic Power Laboratory, Pittsburgh, Pennsylvania; and
- General Electric Company, Syracuse, New York.

SSN-21 Program Status

The SSN-21 program is generally on schedule, but it has experienced some cost increases in the detail design phase. Due to late delivery of combat system design data and the possibility of further design changes, some components currently not meeting noise goals, and lack of operational testing, the prospects of the program staying within schedule and cost are questionable. Also, the overall performance capabilities of the SSN-21 and its ability to provide the quantum improvements in submarine warfighting capabilities will not be known until operational testing is conducted in the mid 1990s.

Cost

In terms of 1985 base year dollars, the Congress had appropriated $4.0 billion through fiscal year 1989 for the development and production of the lead SSN-21 and the AN/BSY-2 combat system. These funds include $2.2 billion for research and development, of which $266 million is for the reactor and other nuclear components, and $0.7 billion for AN/BSY-2 development. Shipbuilding and conversion funds amounting to $1.9 billion have been appropriated for production of the lead ship, long lead items for the next two submarines to be authorized in fiscal year 1991, and the first production unit of the combat system. (Table II.1 shows a break down of the Navy's funding requirements.) By the beginning of fiscal year 2000, the Navy plans to have 13 SSN-21s in the active fleet and 16 in various stages of construction. The Navy estimates that the development and production cost of these 29 SSNs, including the combat systems, will be $36 billion.

Table II.1: SSN-21 Program Acquisition Funding Requirements Through Fiscal Year 1999 (In Fiscal Year 1985 Constant Base Year Dollars)

Dollars in billions

	Fiscal year 1989 and prior	Fiscal year 1990	Outyears	Total
SSN-21 (without AN/BSY-2)				
Development	$1.45	$0.19	$0.72	$2.35
Production	1.64	.39	24.53	26.56
Total[a]	**$3.08**	**$0.58**	**$25.25**	**$28.91**
AN/BSY-2 combat system				
Development	$0.71	$0.28	$0.57	$1.56
Production	.24	.20	5.04	5.48
Total[a]	**$0.95**	**$0.49**	**$5.60**	**$7.04**
Total[a]	**$4.04**	**$1.06**	**$30.85**	**$35.95**

[a]Totals may not add because of rounding

Newport News Shipbuilding is responsible for the submarine's overall design under a cost-plus-fixed-fee contract. The company has reported a cost increase under this contract, which has an authorized cost of $343 million. (The exact amount of the cost increase is considered to be proprietary information by the contractor.) The increased cost, according to Newport News, is the result of design changes the Navy has requested, the cost of training employees in computerized design, productivity in the design effort being less than that expected, and employee turnover.

Electric Boat is designing the engine room and its equipment under a cost-plus-fixed-fee contract that has an authorized cost of $212 million. Electric Boat's cost report shows a cost increase, but the Navy believed that this figure was invalid because the contractor's budgeted costs, against which actual costs were compared, were incomplete. (The exact amount of the cost increase is considered to be proprietary information by the contractor.) To control potential cost growth, the Navy has established cost caps for the SSN-21 program, including $1.8 billion for the combat system's development and $1.908 billion for SSN development. The development cost cap for the SSN-21 excludes $383 million of nuclear component development and $90 million for certain other SSN-21 related development efforts.

The Navy has set a cap of $1.6 billion for production of the first submarine and $1 billion for the fifth and following submarines. These caps do not pertain to the second through fourth submarines and exclude the added costs of constructing the ninth and following submarines with HY-130 steel.

Program costs may increase further because of unanticipated problems with the use of HY-130 steel to construct the later submarines, possible understated operational and support costs, and additional changes to the AN/BSY-2 design data.

Hy-130 Steel

Use of HY-130 steel will increase costs by about $70 million for each submarine and permit deeper diving depths. HY-130 steel has never been used to construct U.S. ships or submarines. Thus, before it can be used, the Navy must certify contractors as being capable of producing both the steel and suitable welding materials.

Both Newport News and Electric Boat are involved in efforts to use this steel. Newport News is developing a second source of welding materials and a new welding technology. Electric Boat is constructing a hull ring

made of this steel that will be sealed at both ends with similar steel. This sealed hull ring will be taken to sea and subjected to an extensive test program to ascertain operational suitability for the new type steel. The Navy had planned to weld this hull ring into an existing submarine and to subject the modified submarine to tests at sea. However, it dropped this plan in February 1989 because of costs.

The Navy does not believe the technology to manufacture and work with this steel presents significant risks, but it anticipates difficulty in finding companies interested in producing suitable welding materials. According to the Navy, because profits are to be found in manufacturing rather than in development, companies that can develop these materials will be reluctant to do so without some assurance that they will be given contracts to produce the materials.

Operating and Support Costs

Estimated operating and support costs for the SSN-21 may be low. The Navy estimates these costs through fiscal year 1999 at $791 million. The Navy's life-cycle cost estimates, including operating and support costs, were independently reviewed by both the Naval Center for Cost Analysis and the Office of the Secretary of Defense's Cost Analysis Improvement Group (CAIG). The Naval Center concluded that the cost estimates, including operating and support costs, were reasonable.

CAIG concluded that the development and procurement cost estimates were reasonable but believed that the operating and support costs were understated. It indicated, among other reasons, that the operating and support cost estimate did not include the cost of certain maintenance equipment that the group believed would be required and that the Navy's estimate of time required to accomplish the single overhaul scheduled for each submarine was optimistic. DOD, in its comments on a draft of our November 1989 report, stated that the Navy had addressed the CAIG's concerns.

AN/BSY-2 Design Changes

Changes to the design of the AN/BSY-2 combat system caused a portion of the ship to be redesigned, and the Navy estimates the cost of these changes to be $5 million. The Navy originally provided Newport News with general information regarding space and weight requirements for the combat system that the shipyard used to begin designing its portion of the submarine. The Navy later provided Newport News with more specific information that, according to the shipyard, caused considerable redesign of the submarine and increased design costs by $3.4 million.

Further combat system design changes were made that the Navy estimates will, in turn, necessitate design changes to the SSN-21, costing an additional $1.6 million.

Additional cost increases, according to Newport News, could result because of further design changes to the combat system. SSN-21 design contracts are cost type, which means the government, not the contractors, will bear the risk of unexpected additional costs. However, the Navy believes the impact of further combat system design changes on the submarine's design will be minimal.

Schedule

Some changes in the SSN-21 program may slightly delay the program schedule. Newport News and Electric Boat are 1 to 2 months behind in delivering design drawings to the Navy. However, this did not delay starting construction on the lead SSN-21 in October 1989.

The planned delivery date of the lead ship, however, has been extended from November 1994 to May 1995 (see table II.2). According to the Navy, this date was extended to permit more efficient production and hence a lower price from the contractor. The Navy also indicated that it believed the SSN-21 design schedule could have fallen short of supporting the original delivery date of November 1994 by some 6 to 8 months.

Table II.2: SSN-21 Program Schedule

	Milestone dates	
Milestone event	**Original**	**Current**
Program initiated	July 1982	July 1982
Preliminary design authorization	Dec. 1983	Dec. 1983
Design contract authorization	May 1985	June 1985
Full scale development	June 1985	June 1985
Detail design authorization	Oct. 1986	Oct. 1986
Lead ship authorization	June 1988	June 1988
Production contract for lead ship	Nov. 1988	Jan. 1989
Start construction	Nov. 1989	Oct. 1989
Authorization for 2nd and 3rd ships	Mar. 1990	Mar. 1990
Production contract for 2nd and 3rd ships	Nov. 1990	Nov. 1990
Start construction of two follow-on ships	Mar. 1991	Mar. 1991
First ship delivery	Nov. 1994	May 1995
Delivery of 2nd ship	Aug. 1995	Aug. 1995
Delivery of 3rd ship	Mar. 1996	Mar. 1996

In 1987 we testified[1] on the importance of having a firm AN/BSY-2 combat system configuration so that the SSN-21's design could be finalized and validated before construction starts. Subsequently, in a March 1989 report,[2] we expressed concerns about the contractor's ability to develop and test the large amount of AN/BSY-2 software and meet the system delivery schedule. Our concerns about the AN/BSY-2 development and its impact on the SSN-21's capabilities and schedule still exist.

As shown in table II.2, the SSN-21 schedule has a 27-month gap between detail design authorization and lead ship construction contract award and a 22-month gap between awarding contracts for the lead ship and the second ship. Navy officials believe this approach will allow them time to identify any required modifications before a number of submarines are under construction. The Navy believes that the planned concurrency of development and production of the SSN-21 will not adversely affect cost, schedule, and performance goals.

The Navy believes that innovative production techniques, including the use of modular construction and computer-aided design, will enable the contractor to build SSN-21s faster than previous submarines have been built. The Navy expects the lead submarine to be built in 67 months and most of the later ones to be built in 50 months each. In comparison, SSN-688s have taken over 70 months to build, even though these submarines are a third smaller than the SSN-21.

Performance and Developmental Testing

The overall combat effectiveness of the SSN-21 will not be precisely known until it is operationally tested, beginning in fiscal year 1995. However, except for two components, developmental test results of some components and systems appear satisfactory.

Several SSN-21 component systems, including hull, electrical, and mechanical systems and components of the AN/BSY-2 combat system, were tested at sea, and the Navy indicated that no significant problems were found. Component testing also is being performed at land-based sites and on scale models.

[1]Status of the Navy's New Seawolf Attack Submarine and its New Combat System (GAO/T-NSIAD-87-14, Mar. 24, 1987).

[2]Submarine Combat System: Technical Challenges Confronting Navy's Seawolf AN/BSY-2 Development (GAO/IMTEC-89-35, Mar. 13, 1989).

The Navy believes the modeling and simulation projections of the SSN-21's combat effectiveness indicate that the specified quieting and combat system thresholds can significantly enhance the sonar search rates and threat detection capabilities. However, modeling results were insufficient to project the overall combat effectiveness of the SSN-21.

Some SSN-21 equipment and systems will not be operationally tested before production. Thus, to assist in identifying deficiencies at the earliest point in production, a Navy operational test group will monitor selected factory, production acceptance, and land-based tests during lead ship detailed design and production. It also will monitor developmental testing, perform an independent analysis of applicable simulations, and, whenever possible, conduct operationally oriented testing to support an assessment of the SSN-21 before the 1990 decision for construction of follow-on SSN-21s. As part of this assessment, the group will independently review and validate modeling and simulation used to project the SSN-21's combat effectiveness.

Operational Testing

In an opinion dated February 27, 1989, we concluded that the SSN-21 program could not proceed beyond low-rate initial production on the basis of "early operational assessments" that did not constitute operational testing. The opinion was provided at the request of the Chairman, Legislation and National Security Subcommittee, House Committee on Government Operations.

The law (10 U.S.C., section 138) stated that the DOD Director of Operational Test and Evaluation must analyze the results of the operational test and evaluation that has been conducted for each major defense acquisition program and report whether the results confirm that "the items or components actually tested are effective and suitable for combat." The law required that the report be furnished before a program may proceed beyond low-rate initial production. Another statute (10 U.S.C., section 2366) provided that major defense acquisition programs may not proceed beyond low-rate production until initial operational test and evaluation is completed.

The acquisition schedule for the SSN-21 program provides that contracts for 14 additional submarines will be awarded before the first one is available for operational testing. The DOD Director of Operational Test and Evaluation believed that legal requirements could be met by "early operational assessments" without the need for actual operational tests

on the system. The early operational assessments would include computer modeling and simulations, coupled with development testing. We concluded, however, that the law required actual operational testing of the system under realistic combat conditions.

Because of the time involved, the Navy did not believe it was reasonable to delay a program to construct large, complex ships long enough to construct one or more of them and to operationally test them. The Navy believed that awaiting operational testing of the first SSN-21 before contracting for more submarines would result in a prohibitive delay of 5 or 6 years in the program and a large cost increase. For that reason, it had no plans to change its acquisition schedule. However, in its comments on a draft of our November 1989 report, DOD indicated that actions were underway to seek legislative relief from the legal requirement. In November 1989, a new section (10 U.S.C., section 2400) was enacted concerning this issue.

AN/BSY-2 Combat System

A fully capable AN/BSY-2 is critical to the success of the SSN-21 achieving its mission requirements. The AN/BSY-2 combat system is a computer-aided detection, classification, and tracking system with two major subsystems—sonars and combat control (fire control and weapons launch)—and is to be more automated and more capable than the AN/BSY-1 combat system.[3] Using a new wide aperture array[4] and enhanced integrated information management, the AN/BSY-2 is being designed to improve response time, operability, and firepower capabilities needed for the SSN-21 to counter the increased Soviet submarine warfare threat. According to the Navy, the AN/BSY-2 is intended to take advantage of significant noise reductions expected of the new SSN-21; however, if the SSN-21 does not meet its noise quieting requirements, the AN/BSY-2 will be less effective.

The Navy states the system's performance requirements will be achieved by including proven technologies from previous combat system programs, not from using new technology. For example, the AN/BSY-2 is to contain modified hardware from the AN/BSY-1 combat system.

[3]The AN/BSY-1 is the improved SSN-688's combat system.

[4]A wide aperture array is a passive sensor that will be mounted on the SSN-21's hull. The array is expected to provide enhanced passive sensing capabilities that will allow the combat system to determine locations of targets faster and provide more accurate target range and target motion analysis.

The system's new and larger acoustic sensors are to significantly improve detection capabilities and provide more accurate target and motion data than those previously available. The AN/BSY-2 also is designed to significantly improve ship data processing and management capabilities. For example, certain tasks (e.g., searching, detecting, and tracking targets and setting the firing order of various weapons) are currently performed manually or with limited computer assistance. The AN/BSY-2 will reduce the time operators need to perform these tasks because it will include faster and more capable computers and new customized work stations, data displays, and additional software. These improvements also will allow operators to perform multiple tasks, address multiple targets concurrently, and process additional tactical data faster and more accurately.

Collectively, these capabilities should reduce the response time between initially detecting a target and launching a weapon. According to the Navy, other combat systems cannot offer this capability. The Navy's Operational Test and Evaluation Force stated that the AN/BSY-2 has the potential for improved effectiveness over prior systems; however, the Navy cannot demonstrate this capability until the system is operationally tested, which is scheduled 2 years after delivery of the first system. Problems encountered during such tests could require redesign and/or configuration changes to systems delivered and under development, which could further delay deliveries and increase costs.

As of March 1989, the AN/BSY-2 program was about 3 months behind schedule and two important Navy design reviews that will determine the extent to which the system will meet specification requirements had been delayed about 5 months. In addition, a DOD assessment has identified problems in developing two combat system components—the wide aperture array sonar system and the enhanced modular signal processor. A difference in maturity between the AN/BSY-2 and SSN-21 programs has affected the ship's design, and indications are that further AN/BSY-2 program schedule slippages may occur. A delay in development and delivery of the first combat system could delay construction of the first SSN-21.

The Navy has no backup combat system planned, nor can it use the AN/BSY-1 if the AN/BSY-2 is unavailable because the AN/BSY-1's configuration is not the same as the AN/BSY-2's. In its comments on a draft of our November 1989 report, DOD stated that a backup combat system was not required because the AN/BSY-2 hardware and software were being designed to be built and written modularly. The Navy expects the

hardware to be delivered on time and the software to be delivered incrementally with final delivery taking place before technical and operational testing. Should software development delays happen, the Navy believes that the modular development and incremental delivery approaches will give the system and SSN-21 basic warfighting capabilities while the problems are being resolved.

The lead shipyard for the submarine design advised the Navy in an October 1988 letter that its assessments indicated the AN/BSY-2 development program was 12 to 16 months behind that needed for a November 1994 submarine delivery schedule. The submarine delivery schedule was subsequently extended 6 months, to May 1995. Further combat system delays or changes could have a major impact on the SSN-21 program's cost and schedule.

In its comments on a draft of our November 1989 report, DOD said that shipyard officials subsequently stated that there was no reason to believe the AN/BSY-2 combat system would not support lead ship delivery. After receiving DOD's comments, we contacted the shipyard again, and we were told by an official that the shipyard had no basis for an assessment of the AN/BSY-2 program and should not have expressed an opinion on the status of the program.

SSN-21 Cost May Affect SSN Force

Due to fiscal constraints, the Navy may not be able to achieve and maintain its 100 SSN force goal unless it devotes substantially more of its shipbuilding budget to building SSN-21s. The Navy does not believe building a mix of SSNs, such as the SSN-21 and the less costly SSN-688, would provide it with a force as effective as that currently planned. Rather, the Navy says that if SSN-21 affordability becomes an issue, it would rather reduce its SSN force level.[1]

SSN Force Structure Analysis

The Navy plans to achieve its minimum SSN force level goal in the 1990s by requesting authority for 29 additional SSNs—1 SSN-688 and 28 SSN-21s. During this same period, however, the Navy will have 32 SSNs that will have been in service 30 years, and it will be faced with block obsolescence of its SSN-637 class (10 of these SSNs will reach 30 years of age in fiscal year 1999). As a result, the Navy will have to keep an increasing number of older SSNs in service to achieve its force level goal. In its fiscal year 1990/1991 plans, the Navy deleted funds for three of the last four SSN-688s. The Navy was not able to provide us with SSN force level projections through fiscal year 2010.

Our analysis shows that the Navy's SSN construction plan is based on several assumptions that may not be achievable. If the SSN construction plan is executed as prepared, then the SSN construction program may jeopardize other ship construction programs. In our analysis of the plan, we found that to meet the construction plan the Navy must

- experience sustained annual shipbuilding and conversion budget growth of 3 percent above inflation;
- increase the percentage of shipbuilding and conversion funds allocated to SSN construction from 19 to 26 percent;
- reduce average planned SSN construction time from 65 months to about 52 months;
- obtain congressional approval and funding for 29 SSNs, or an average of about 3 ships per year;
- continue the SSN-21 program or initiate a similar SSN program with a construction rate of three ships per year and with similar cost and schedule requirements;
- incur no cost overruns that require supplemental funding; and

[1] At the beginning of fiscal year 1989, the Navy had 97 SSNs in its active force—4 pre-Permit class, 13 Permit class (SSN-594), 2 Ethan Allen class (SSN-608), 37 Sturgeon class (SSN-637), 1 Narwhal class (SSN-671), 1 Lipscomb class (SSN-685), and 39 Los Angeles class (SSN-688).

- maintain older SSNs in service for 30 years without attrition due to accident or war.

We analyzed future SSN force levels by assuming that in the 1990s the shipbuilding and conversion budget would experience a (1) 3 percent real growth, (2) zero real growth, and (3) negative 3 percent real growth and would remain in real terms at the 1999 levels through the next decade. In all three projections, we assumed that SSN construction would consume 26 percent of the shipbuilding and conversion budget, all SSNs would be built within construction cost caps, no SSN would be lost due to war or accident before achieving its 30-year service life, and a follow-on program similar in cost and schedule to the SSN-21 program would be authorized in fiscal years 2000 through 2009. Likewise, in each projection, we made different assumptions about the overall size of the Navy's shipbuilding and conversion budget for fiscal years 1990 through 2009 and the time lag between authorization and delivery dates.

The details of our analysis have been classified by DOD. However, our analysis showed that with a consistent 3 percent real growth shipbuilding budget, the Navy would be able to execute its SSN shipbuilding plan and generally achieve and maintain its 100 SSN force level goal through the year 2010. Conversely, zero or negative real growth shipbuilding budgets, without adjustments in other shipbuilding programs, would not allow the Navy to achieve and maintain its SSN force level goal.

Forecasting is an inexact science that seldom, regardless of the method used, exactly forecasts what will happen in the future. Such analyses, however, use numerical data and thus unavoidably appear to be more precise than they ever can be, and our analysis of the Navy's SSN force structure is not different in this regard. We would like to emphasize that our analysis was not meant to precisely predict SSN force levels. Instead, it is intended to explore what is likely to happen in the future, based on what we know about the past, and to analyze how different policy decisions would affect SSN force levels.

During the 1980s, SSN construction consumed about 19 percent of the Navy's shipbuilding and conversion funds. In contrast, our analysis shows that with 3 percent real growth annually in the Navy's shipbuilding and conversion budget during the 1990s, 26 percent of those funds would be needed to fully fund SSN construction programs. Further, if the shipbuilding and conversion budget has zero real growth, the Navy

would need about 31 percent of those funds to fully fund the SSN program. With a 3 percent annual decrement in the budget, the Navy would need about 36 percent of those funds for its SSN construction program.

The SSN-21's acquisition cost will be significantly more than the SSN-688's, but Navy studies have concluded that when life-cycle costs of the two SSN classes are compared the SSN-21 will only cost about 10 percent more over its 30-year life. The Navy has indicated that if SSN-21 affordability becomes an issue, it would rather reduce the submarine force level than provide a mixed force.

Conclusions

On the basis of affordability issues and past shipbuilding achievements during the 1980s, it appears unrealistic to assume that the Navy can achieve a sustained 3 percent real growth in funding for ship construction throughout the 1990s or that it can carry out its construction schedule as quickly as planned without cost overruns. As a result, the Navy's SSN force will likely decline below the 100-ship goal in the cases of zero and negative growth in ship construction funding. Force levels will decrease primarily because of the block obsolescence of SSN-637 class submarines at the turn of the century—10 of these ships will reach 30 years of age in fiscal year 1999. Budget reduction measures decrease the planned construction rate from 3 new ships per year to 2.5 or 2.2 ships, and even if construction progresses on schedule, the number of new SSNs coming into the fleet will not make up for the loss of these older ships into the 21st century.

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